Stereo IKONOS is a viable tool for estimating young forest growth

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Forest carbon (C) stock is a poorly understood component of the C-cycle. Growth estimates from IKONOS and Landsat are analogous to height and carbon sequestration estimates from field data.

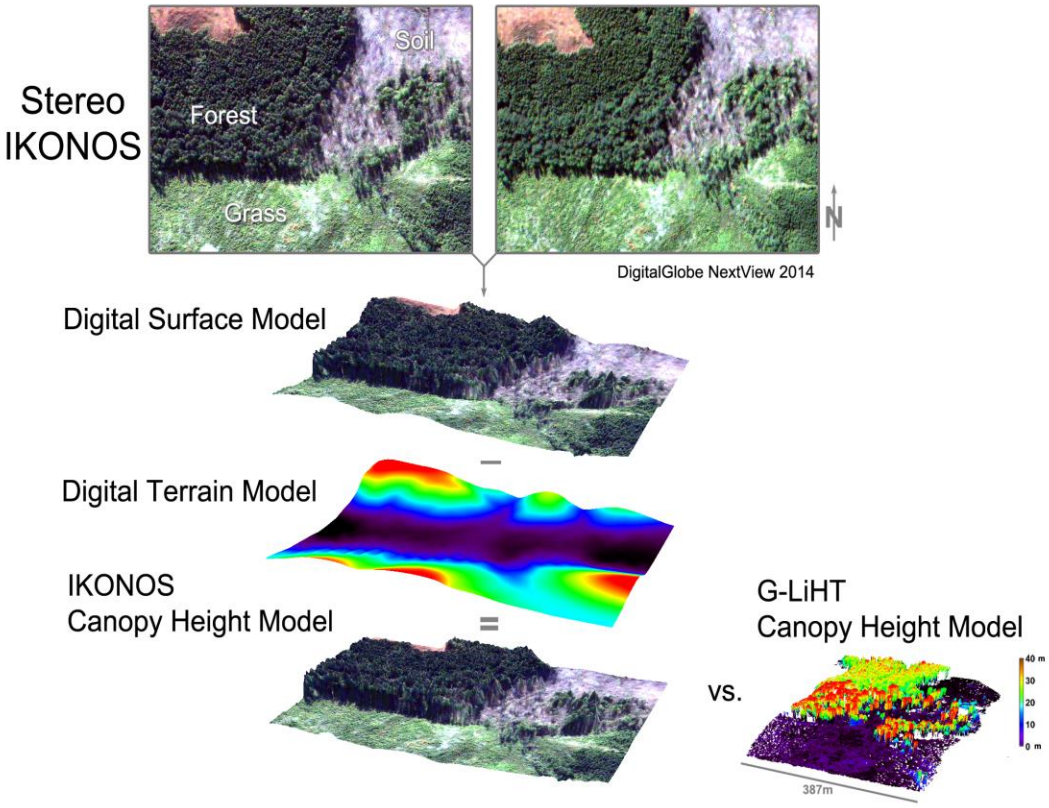

Fig. 1 Method for generating canopy height models from stereo IKONOS imagery in Hoquiam WA. We compared canopy height models between IKONOS and LiDAR from G-LiHT which served as truth, 19 of 20 sites in the US had valid estimates.

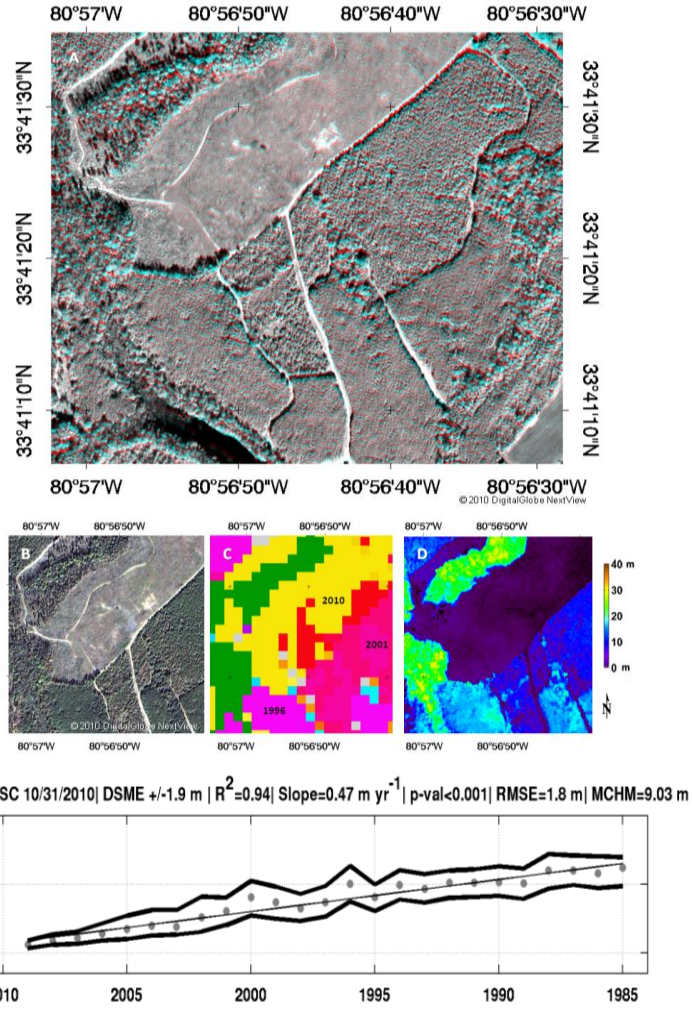

Fig. 2 (A) 3D image of agroforestry (B) IKONOS true color image (C) Landsat disturbance and (D) IKONOS height estimate. © DigitalGlobe NextView 2010 Bottom, forest growth estimate using a *space-for-time* swap of the same location.

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Abstract:
Forests account for a majority of the aboveground carbon stock, but large uncertainties about its distribution remain. We compared forest height, a proxy for carbon density, from airborne LiDAR recognized as truth, to 1 m panchromatic commercial stereo IKONOS imagery that is widely available. Physically meaningful forest structure information can be retrieved from IKONOS stereo imagery and height estimates are correlated to airborne LiDAR.

References:

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Data Sources:
The analysis was performed as part of the North American Forest Dynamics (NAFD) project, a NASA-funded investigation to improve characterization of US forest disturbance patterns in support of the North American Carbon Program (PI: Samuel Goward, University of Maryland; GSFC CO-I: Jeffrey Masek, Code 618 NASA GSFC). IKONOS imagery were collected from the National Geospatial Intelligence Agency (NGA) under the NextView license agreement with DigitalGlobe and Goddard's LiDAR Hyperspectral and Thermal Imager, (G-LiHT) airborne LiDAR data were collected as part of a the AMIGA-Carb project which is another NASA funded investigation.

Technical Description of Images:

Figure 1. A 3-D graphical description of how canopy height models (CHMs) were created from Stereo IKONOS imagery near Hoquaim WA. True color pan-sharpened IKONOS imagery was subset to show details of forest structure. (top) Left and right within track 1 m resolution stereo IKONOS data were processed calculating image parallax to extract a digital surface model (DSM). (middle) A digital terrain model (DTM) derived from the national elevation (NED) dataset was then subtracted from the DSM to produce CHMs which is an estimate of canopy height with no terrain. We compared CHMs between IKONOS and Goddard's LiDAR Hyperspectral and Thermal Airborne Imager (G-LiHT) which acted as truth.

Figure 2. Regrowth estimate with multi-date disturbance history from Landsat and single date height estimate from stereo IKONOS.

Scientific significance:
The spatial distribution of aboveground forest carbon is poorly known over many areas of the globe. Estimates of forest carbon are required for accurate prediction and modeling of changes in carbon sinks and sources. This work is the one of the first to demonstrate that very high-resolution commercial stereo imagery provides highly accurate forest structure in different ecoregions of the US. Combining these data with models one could to infer total aboveground carbon stock and change.

Relevance for future science and relationship to Decadal Survey:
Forest carbon is a critical component of the carbon cycle, and is sensitive to climate change and disturbances. Forest structure observations from very high-resolution commercial instruments are available at no direct cost through NGA's NextView license agreement with DigitalGlobe. Combining these data with Landsat disturbance history, airborne and field measurements, one could provide the necessary data products to infer aboveground carbon stock in forests worldwide. Current work has been extended to study the taiga-tundra transition zone to reduce uncertainties about the distribution of forest cover and establish a baseline extent of the northern forest limit.